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XXXIX.—*Notes from the St. Andrews Marine Laboratory*  
(under the Fishery Board for Scotland). By Prof.  
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[Plate XVI.]

II. *On the Spawning of certain Marine Fishes.*

*Clupea harengus.*

On the morning of February 5th a boat reached St. Andrews harbour from the fishing-ground, having on the deck a quantity of the eggs of the herring, which probably had been shaken from the nets and had been for several hours in the open air. Some of the ova were collected by the hand and brought to the marine laboratory, where they were placed in a vessel under a tiny trickle of sea-water. Their development was not specially studied, though Mr. Alex. Thomson\*, one of the students of natural history, made a few notes and several drawings at various stages. The main feature of interest in connexion with the experiment was the vitality of the eggs. The first embryos emerged from the eggs on the 6th March at noon, and thus a month elapsed from the date

\* First Prizeman in the Natural-History Class of this Session.  
*Ann. & Mag. N. Hist. Ser. 5. Vol. xv.* 30

of deposition, the lengthened period being probably connected with the low temperatures of the season. Thus it would not appear that the statements made as to the injury or disturbance of these ova by the sole or ground-rope of a trawl require qualification. As a rule the eggs of fishes deposited on the bottom, such as those of the herring, cottus, lump-sucker, and Montagu's sucker, are by no means delicate. Indeed, if nothing more befalls them than conveyance on deck by the trawl and subsequent tossing overboard into the sea, they will be little worse for the accident. It is by such means that many of the young fishes have been procured for observation. It would be well, however, for trawls to avoid ground covered with herring-spawn, especially at the hatching of the embryos, as these would be more liable to succumb to pressure of any kind than the ova, though they are more capable of getting out of its way. The young herring, on its escape from the egg, is much less active and vigorous than the young of other fishes with fixed eggs, such as Montagu's sucker, for the former were unable to make much progress above the bottom for some days, while the latter at once disported themselves throughout the water, shooting here and there like ephemera in the air.

*Zoarces viviparus*, L. Viviparous Blenny.

Many of the viviparous blennies collected in November and December were characterized by the great distention of the abdomen, as, indeed, previous observations had shown. The opinion of Willughby, therefore, that the species brings forth young in the depth of winter, seems to be most in accord with the condition on the Scottish shores, for the well-developed young are found in the ovary in November, December, and January.

In the fully developed female the embryos at this season lie over each other in compact masses in the ovarian cavity amidst a quantity of fluid. Moreover, so far as observed, the size of the adult does not appear to be connected with that of the young on extrusion, though the number may be. Dr. Shaw, however, found in a very large female (15 in.) that the young on extrusion measured nearly 5 inches. In a large female in which the young were accidentally discharged through a wound in the abdominal wall in November their length was 41 millim., while those normally produced in January from smaller specimens were 51 millim. in length. The lateral regions in these young forms are mottled with dark brownish touches on pale olive, the markings beneath

the dorsal fin somewhat resembling Arabic characters. A darker band runs along the lower lateral region, and in this are a series of silvery spots. The dorsal fin is marked as in the adult. The coloration thus indicated is present before the extrusion of the young fish. The yolk-sac is almost absorbed, only a slight enlargement occurring in this situation. They seek the shelter afforded by crabs, stones, submerged wood, and similar structures, since they are readily devoured by the young cod, haddock, whiting, and other fishes (including their parents). When unmolested, however, as in a separate vessel, they stretch themselves at various heights on the horizontal branches of *Eudendrium* and other zoophytes, and feed on the hydroids and minute crustaceans that lurk amongst the twigs.

In the ovary the embryos lie over each other in a compact mass; yet in life the fluid in the chamber not only moistens the branchial apparatus, but enables them to glide over each other with ease. The ovarian cavity is single, and its wall is comparatively thin. Moreover, stretching inward from the latter are numerous long villous processes, which in shape are often clavate, narrow at the base and wide at the tip. In some the tips are expanded so as to form somewhat flattened sucker-like surfaces. The wall of the ovary presents in transverse section a thick epithelial layer externally (Pl. XVI. fig. 1, *a*), while the stroma beneath consists of mixed fibres and cells (*b*), the former including a considerable proportion of muscular fibres and the latter many nucleated cells. To this coat are attached the membranous vascular lamellæ just mentioned, and which, when viewed as transparent objects (Pl. XVI. fig. 2), show a complete meshwork of anastomosing blood-vessels, which do not seem to be reduced to the size of capillaries, since in the smallest twigs several blood-corpuscles pass in column. A large volume of blood is thus carried swiftly into the organ. In transverse section, moreover, it is found that these vessels are arranged along the external margins of all the folds (Pl. XVI. fig. 1, *c, c*), so that they are in close contact with the fluid in the ovarian chamber. A thin epithelial coat with connective or basement-tissue beneath alone intervenes between them and the cavity. The walls of these blood-vessels are somewhat thick. In specimens examined immediately after the discharge of the young fishes the vessels are remarkably large and conspicuous as well as gorged with blood. While preserving in the main a longitudinal direction, each trunk has connexions with the adjacent vessels at short intervals. The villous processes carrying these vessels fill the ovarian chamber at this time (after

extrusion of the young), while small intermediate ova on short pedicles are studded on the surface of the thin wall.

The chief feature of the male is the muscularity of the sperm-ducts, the terminations of which are stated to be capable of eversion, so as to facilitate the introduction of the male elements into the ovarian chamber. This also would readily be accomplished if, as in certain other marine forms, the seawater containing them gained admission to the cavity of the ovary.

*Ovaries of the Catfish (Anarrichas lupus, L.).*

The somewhat close approach made by the catfish to the foregoing species made the examination of its ovaries noteworthy in this connexion\*. In shape these considerably differ, since they are separate anteriorly and connate posteriorly, as usual in many fishes. Their walls are also much more massive. There is considerable similarity, however, in the arrangement and connexion of the eggs with the ovarian wall, to which they are fixed like large flattened bunches of grapes. In a female procured during the trawling experiments at the end of August (29th) the majority of the ova are about 4 millim. in diameter, each being attached by fine thread-like bands of tissue. The membranous parts of the folds to which the ova are attached show, in addition, numerous microscopic ova. The vascularity of this tissue is slight, and in striking contrast with the villous processes in the ovary of the viviparous blenny. The ovaries of a specimen obtained in February were unusually coarse internally from the presence of numerous large ova (5 millim. in diameter) amongst the smaller. Some of the large ova were quite free and apparently ready for extrusion, while others were fixed to the membranous pedicles and folds, which presented many branching blood-vessels, as well as more minute ova. The latter seem to be developed everywhere in the stroma of the ovary and its villous processes. From the variable size of the ova in this instance the spawning-period probably extended over a considerable time. The ova are, further, evidently deposited on the bottom.

Towards the posterior part of the organ, viz. about an inch and a half behind the fork, in the latter specimen are several bullæ, which have whitish albuminous contents. They are visible on both sides of the wall.

\* In connexion with the development of the Teleostean reproductive organs an interesting paper by Jules MacLeod will be found in the 'Archives de Biologie' (of Van Beneden and Bambeke), vol. ii. p. 497, pls. xxix., xxx.

*Ova of the Short-spined Cottus (Cottus bubalis, Bloch).*

So little definite information has hitherto been available with regard to the spawning of this species, that in the recent and excellent work by Mr. Francis Day the following account is given:—"Breeding: In Greenland it has been observed to deposit its eggs on the seaweed in December and January. Its eggs are very small, and in this country are extruded during the spring in the sand or pools in the rocks. The male is said to make a nest of seaweed and pebbles for the reception of the spawn, while he is believed to watch over and protect the young when hatched." On the other hand, Prof. Alex. Agassiz observes that the ova of certain American *Cotti* are pelagic. It was not till the 1st of March that a female deposited its ova (Pl. XVI. fig. 4) in the laboratory. This specimen had been isolated and its movements somewhat limited, and it is probable therefore that the deposition may have been hastened. A large quantity of faint pinkish ova were extruded in a few seconds, and they adhered firmly together, forming a mass like that of the lump-sucker (Pl. XVI. fig. 3), though they were individually smaller, viz. 1.5 millim. in diameter. An examination of its ovaries shortly afterwards showed that a few ova were still present. Subsequently others deposited eggs of a beautiful roseate hue, of a deep red or of a pale straw-colour. All adhered very firmly together, yet leaving a series of cavities, so that the whole mass, as in *Cyclopterus*, imbibes and retains water, a provision of importance in the case of eggs deposited near low-water mark. The egg-capsule is thick, tough, and resistant, and shows the facets or processes by which it adheres to neighbouring ova. This coat is seen to be minutely punctured under a high power. None of the ova deposited in the tanks seem to have been fertilized. Many reddish examples (in mass) were procured from the rocks towards the latter third of March, and in these the embryos were well advanced.

This species is one in which the ova attain a nearly uniform size in the ovaries, and are extruded simultaneously. At the full period, indeed, the ovaries are heart-shaped, only a slight sinus occurring in the middle line anteriorly, while the posterior end is bluntly conical.

*Armed Bullhead (Agonus cataphractus, L.).*

The ova of this species were nearly ripe in a specimen trawled on March 12, in St. Andrews Bay, where they abounded amongst the sand. They had a pale salmon-colour and a diameter of 1.3 millim. They are somewhat less re-

sistant than those of the short-spined cottus, and have a thinner capsule, which is minutely and somewhat regularly punctured. They are probably deposited on stones, seaweeds, and other structures. A male showed fully developed spermatozoa at the end of January.

*Bimaculated Sucker* (*Lepadogaster bimaculatus*, *Donov.*).

The ova are somewhat irregularly arranged over an area of a square inch or two inside the valves of dead specimens of bivalves, such as *Solen siliqua*, in July. The eggs do not touch, but are firmly attached at somewhat regular distances to the smooth surface. In one instance the eggs occurred (with the adult) inside the hollow bulb of *Laminaria bulbosa*; and as the embryos were far advanced, it is probable, as Mr. Hyndman observes, that the adult remained in charge of them, even when subjected to the rough treatment of the dredge. In the latter case, the eggs were less regularly arranged than on the smooth inner surface of the *Solen*. The egg-capsules have very evident punctures.

*Montagu's Sucker* (*Liparis Montagui*, *Donov.*).

Almost the only kind of ova procured by the local trawlers (liners in their fishing-boats), in February, March, and April, is that apparently of this species, attached to various zoophytes, such as *Hydrallmania falcata* and *Sertularia abietina* (Pl. XVI. fig. 5) and on various algæ. They are considerably smaller than either of the species figured, measuring only  $\frac{1}{20}$  inch in diameter, and are remarkable for the almost arcolated appearance caused by the conspicuous punctures. They are of a light straw-colour and form firm masses on the zoophytes or algæ, while they are easily developed in the tanks, even after considerable exposure in the open air on the deck of a boat. Moreover, the embryos are well developed, especially in regard to the organs of circulation, pigment on the anterior region, pectoral fins and powers of locomotion, since on escape they at once swim through the water.

*Pelagic Ova.*

During the experiments on behalf of H.M. Trawling Commission many pelagic (or floating) eggs were examined. Those familiar with such ova will hardly accept the view that they float in virtue of the oil-globules they contain, since in the common forms, *e. g.* cod, haddock, whiting, flounder, dab, and turbot, no oil-globule is present. Masses of oil-globules, indeed, are more characteristic of ova that lie on the bottom,



or that are fixed to submerged stones and rocks. Amongst others, however, the pelagic ova of the grey gurnard\*, and, as shown by Mr. G. Brook †, the rockling ‡ and the lesser weever § present oil-globules. It is well to remember also that the abundance of oil does not in any degree cause the ova of the cottus, fifteen-spined stickleback, or those of the salmon or trout to float. A feature noticeable in most pelagic eggs is the delicacy of the investing capsule (*zona radiata*) and the crystalline translucency of the yolk-mass. Another is the fact that the embryos produced by such eggs are generally in a rudimentary condition, some, such as the young of the common flounder (*Pleuronectes flesus*), cod, haddock, whiting, and others, being devoid of mouth and anus as well as of blood-vessels. The minuteness and delicacy of the young Gadoids and Pleuronectidæ, and the difficulty of rearing them in confinement after the absorption of the yolk-sac, are considerable obstacles to the successful extension of such forms by artificial means in exhausted water.

In connexion with these pelagic ova the changes which ensue when ova captured and kept in the water of the open sea are placed in littoral water, especially that near a harbour or estuary, have not yet been fully investigated. They are not more remarkable, however, than those which occur in certain adult invertebrates when similarly treated.

#### *The Young of the Ling (Molva vulgaris, Flem.).*

In the Trawling Report allusion was made || to the immature examples of the ling that had come under observation, and which for the most part had been procured by the hooks of the liners. Mr. Day states ¶ with regard to the young, that "the back and sides are yellowish olive, broken up and divided into patterns by pale lilac lines." The striped condition of the young ling affords such a contrast to the boldly spotted state of the young cod that it is desirable to record it in greater detail. About the middle of December a specimen  $3\frac{1}{5}$  inches long was found in a pool at the commencement of the East Rocks. In this an olive-brown band passes from the tip of the snout in a line with the middle of the eye straight backward to the base of the caudal fin-rays. The pale ventral surface bounds it inferiorly, while dorsally a stripe having a beautiful opaline lustre runs from the tip of the snout over the upper part of each eye to the base of the caudal

\* Report of the Royal Commission on Trawling, 1885, p. 633.

† Journ. Linn. Soc. xviii. pp. 273 and 299.

‡ *Ibid.* p. 298.

§ *Op. cit.* p. 360.

¶ *Ibid.* p. 275.

¶ *Op. cit.* p. 306.

rays. The latter band is opaque-white on the tail, and it gives the fish a characteristic appearance. The dorsal fins are well marked, the first presenting a distinct black speck posteriorly, and another black pigment patch occurs at the end of the second. The dorsal line from the brain backward is distinguished by a narrow wedge of dull orange or a mixture of olive and yellow, and this brings out in relief the colours formerly mentioned. The young ling is thus a striped form, and contrasts boldly with the spotted or tessellated condition observed in the young cod.

#### *Young Eel.*

While digging for sand-eels near low water a young eel which presents certain features of interest was found deeply imbedded in the moist sand. The fish measures  $3\frac{1}{4}$  inches in length, and is extremely translucent. Anteriorly, however, a symmetrical pale greenish coloration commences at each eye and passes backward and slightly outward, keeping external to the translucent cranium. Behind the latter a similar greenish band, broad at first, but subsequently narrowing, extends along the anterior vertebral region. The eyes are blackish. At the base of the brain is a little blackish pigment, and a line of the same colour indicates the spinal cord. The dorsal fin begins a considerable distance behind the pectorals, and thus differs from that of the adult conger, in which it commences at the last quarter or the end of the pectorals. The anal begins about the length of the head behind the dorsal, and apparently a little in front of the middle of the total length. The projection of the mandible beyond the premaxillaries is also pronounced. In both of the latter characters, therefore, it leans to the condition in the common eel. The tail is broadly lanceolate from the extension of the marginal fin on both edges, but especially superiorly; a small blackish patch occurs in its middle. The opercular region presents a striated or faintly radiate appearance from the peculiar ossification; the blood is faintly pinkish. This habit of a young eel, which at first sight was supposed to be a conger frequenting moist sand, is interesting.

#### *On the multiple Tumours of Plaice and Common Flounders.*

In Day's 'History of British Fishes'\*, it is mentioned that Lowe describes the common flounder of the Ouse as "affected with a peculiar skin-disease resembling epithelioma—large fungous growths cropping out over the whole body, the granulations large and roe-like—under the microscope

\* Part v. p. 36.



consisting of large nucleated cells." A similar affection is found in this species at St. Andrews and in the Thames, and the same tumours occur on the plaice.

In a male example of the latter, for instance, the coloured surface is crowded with small rounded tumours which resemble shot. They are also attached to the various fins (Pl. XVI. fig. 6) as well as invading the white surface. They are firmly fixed to the skin, give pain when interfered with, and are vascular. The isolated tumours range from 1·7 millim. to 1 millim. or less; the larger masses (Pl. XVI. fig. 6, *a*), when bisected, show a series of smaller areas, the whole being composed of multiple tumours, mostly of the same size (Pl. XVI. fig. 7). In the fresh state section is followed by the exudation of a minute granular whitish creamy substance, and the occurrence of fine fibrillæ under examination indicates that the fluid is probably coagulable. Each chamber is cystic, presenting a firm hyaline wall of considerable thickness, bounding the granular contents. The stroma exterior to the former is chiefly fibro-granular. Smaller cysts in course of development are observed amongst the stroma, the thick translucent hyaline wall being conspicuous. These tumours therefore would appear to differ from the kind with nucleated cells described by Lowe.

EXPLANATION OF PLATE XVI.\*

- Fig. 1.* Transverse section of the ovary of *Zoarces viviparus*, shortly after the escape of the embryos. *a*, epithelial coat; *b*, muscular layer; *c*, section of the blood-vessels at the margins of the villi.  $\times$  about 40 diam.
- Fig. 2.* A fragment of the membrane of a villus, showing the large anastomosing vessels. Magnified.
- Fig. 3.* Ova of *Cyclopterus lumpus*. About the natural size.
- Fig. 4.* Ova of *Cottus scorpius*. About the natural size.
- Fig. 5.* Ova of *Liparis Montaguï*. About the natural size.
- Fig. 6.* Portion of the anal fin of a small *Pleuronectes platessa*, with a multiple tumour and a few detached masses. About natural size.
- Fig. 7.* Transverse section of the foregoing multiple tumour. Enlarged.

XL.—*Some new Infusoria from American Fresh Waters.*

By Dr. ALFRED C. STOKES.

[Plate XV.]

THE following hitherto undescribed Infusoria were originally met with in shallow ponds in central New Jersey, or were

\* I have to thank Mr. Ed. Prince, Assistant-Zoologist at the Marine Laboratory, for the careful drawings in this Plate.